

JUSTUS VON LIEBIG.

PROF. DR. F. W. BENEKE.

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JUSTUS VON LIEBIG,

HIS MERITS IN THE PROMOTION OF
PRACTICAL MEDICINE:

A MEMORIAL ADDRESS

DELIVERED AT THE ANNUAL PUBLIC MEETING OF THE SOCIETY
FOR THE ADVANCEMENT OF THE NATURAL SCIENCES ·
IN MARBURG, ON 11TH JUNE, 1874,

BY THE DIRECTOR,

PROF. DR. F. W. BENEKE,

GEH. MED.-RATH. DIRECTOR DES PATHOLOG. ANATOMISCHEN INSTITUTS
ZU MARBURG, ETC., ETC.

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PREFACE.

IT is hoped that in publishing this translation of Professor Beneke's Memorial Address, giving as it does an epitome at once clear, comprehensive, and sound of the services rendered to Medical Science by Baron V. Liebig, some contribution may be made towards their better recognition, and that of the great fundamental principles he established.

After the lapse of seven years a large addition might, of course, be made to the list of notices of Liebig and his works which had already appeared in 1874, but this need not be attempted here.

ED. TRANS.



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JUSTUS VON LIEBIG.

IN Munich on the 18th of April, 1873, departed this life Justus von Liebig. Already one year and two months have elapsed, since Science mourned the departure of one of her greatest disciples. It is true that time alleviates the sorrow we feel for a loss so great, by teaching us to bear it. But that sorrow cannot die, and those who loved and understood him are constantly led by it to call up his image anew, along with the imperishable monuments he has erected for himself in the regions of mental labour.

It is a criterion of the greatness of creative spirits, that their light shines with clearer brightness and ever-increasing splendour, when their own eyes are closed to the light of day. During their life-time, that light may have been clouded, or even darkened by the shadows which envy, jealousy, or misapprehension had sought to cast upon it. The evening twilight of such a life becomes the morning dawn for generations, and the sun which sets in the one, rises in the other with redoubled splendour which shall never pass away.

It is a farther criterion of intellectual greatness, that, whatever may be the peculiar domain, in which, by pre-

ference, it unfolds its powers, its earnest striving after a perfect understanding of nature as a whole, and of the harmony of individual spheres of knowledge, transcends all labour and experience in single and separate departments, and that, while mastering these last, it still uses and values them, only as building material for the foundation and erection of the great mental edifice it has in view. There are hundreds of learned men, whose names have been registered in the book of the history of science, by single, newly-discovered, far-reaching facts. But those minds rise to a still loftier height, who have revolutionised whole regions of previous belief, more by comprehensive ideas, harmoniously developed, and bearing in themselves the irrefragable stamp of truth, than by the discovery of single facts, and who would have won their world-wide renown, by this manifestation of their genius alone, even if they had not succeeded in adducing full proof of the accuracy of their ideas. It is the divine sparks, which, springing from the brains of these rare mortals, enlighten the world, and continue to enkindle and to extend farther and farther the light of truth and knowledge.

Such rare and superior spirits counted Liebig among their number. What Newton was in the region of Natural Philosophy, Liebig was in the region of Biology.

Already, from several places, has the tribute of gratitude, veneration, and admiration been paid to the illustrious deceased, whose memory we too at this hour would honour. In the Assembly of Naturalists at Wiesbaden, in the autumn of last year, Neubauer made most honourable mention of Liebig. This year, on the 28th March, the Academy of Sciences in Munich celebrated the memory of its departed President, through the eloquent lips of Von Pettenkoffer;

and minute details of what he has effected in the departments of Chemistry, Agriculture, and Physiology, we may expect from Erlenmeyer, Vogel, and Bischoff. In the "Illustrirten Deutschen Monatsheften," a biographical sketch of Liebig was given by F. Mohr; in the newspaper "Unsere Zeit," the departed is celebrated by H. Kolbe as Teacher, Philosopher, and Reformer. After such manifold testimonies, it is scarcely possible, not only for his personal friends, but even for his nearest fellow-labourers, to place the life and achievements of this illustrious man in a new light. The history of his career in life in particular—the development of which was not accomplished without manifold conflicts, in all of which he never lost sight of the great aim he had in view—is a subject which has already been exhausted by the most skilful pens, and it would be superfluous for us to repeat what has already been handed over to us, as matter of history, by the most competent authorities. Still, there seems to me to be a gap, which must not be allowed to remain. Scarcely, or at least only very feebly, are pointed out the merits which Liebig has won for himself in the promotion of practical medicine; and to bring before you, in their full extent, these merits, which are generally not yet sufficiently recognised and estimated, is the task, to which, not without joyful gratitude, I have at this time set myself.

When we speak of the merits of Liebig as regards practical medicine, it is a sufficient proof how little these merits are really understood, that, as a general rule, one thinks first and chiefly on the additions with which he has enriched our diet by the introduction of his Extract of Meat, and his Children's Soup. In these two things, Liebig has undoubtedly afforded valuable assistance to physicians in certain questions relating to diet. The immediate practical

usefulness of both requires no further proof. But both are only single blossoms on the mighty stem of the whole system of nourishment which Liebig founded, and the value of his teaching on this subject for practical medicine we cannot estimate sufficiently highly, little alas ! as it has in practice obtained full understanding, or made actual progress. In fact, one cannot but regard it as incomprehensible, that the clear and unquestionable principles of a scientific system of nourishment, which Liebig has laid down, have been still so little prized and applied by practical medicine as is actually the case. If it should be objected that Liebig has given no definite prescriptions as regards therapeutics, that he has not explained the relations of certain kinds of food to single cases of sickness, that, in short, he was no pathologist, it can only be answered that Liebig certainly was no writer of recipes, but that he has unfolded in the most clear and comprehensive way, those principles, the practical application of which might be left to the discriminating judgment of physicians skilled in physiology. It is not for mechanics, who labour according to a given cut and dried pattern, that Liebig has written, but for thinking physicians, and he who will not take the trouble to gain insight into his whole system of nourishment, who has not made himself quite familiar with his works, he undoubtedly will never be able to make himself master of the treasures which lie concealed in them.

In order to understand this system, we must go back to the grand picture which Liebig was the first to sketch of the circulation of matter in all nature around us. Therein lie the elements of the physiological system of nourishment for the healthy as well as for the sick.

Starting from the plant, Liebig makes it evident that it

draws its nourishment on the one side from the inexhaustible ingredients of the atmosphere, and on the other, from the soil and its inorganic ingredients. The former supplies it with water, carbonic acid, ammonia, and nitric acid; the latter with phosphoric acid, sulphuric acid, silica, silicic acid, potash, soda, lime, iron, and magnesia. What are the powers which co-operate in the formation of organic combinations from these inorganic ingredients, is a question which, till this day, has not been solved with satisfactory certainty. But one firmly established axiom, Liebig placed at the very head of his teaching, and this axiom went to show that the inorganic ingredients of the soil are of the highest importance for the formation of organic combinations from the ingredients of the atmosphere, and that without the existence of these inorganic ingredients, no vegetable albumen, no vegetable acids, no sugar, no starch, no fat, &c., could be formed in the plant. This one doctrine, supported by numerous chemical analyses and agricultural-chemical experiments, became, as is universally acknowledged, the foundation of the present rational system of farming, and with its invaluable consequences, it was quite sufficient to immortalise Liebig's name. But this doctrine was, and is, not less important for the nourishment of animals and men. We learn that, while, in the plant, these inorganic ingredients are fulfilling a definite physiological function, in the formation of those various substances which compose the plant, these same ingredients, introduced as food, along with the substances of the plant, into the bodies of animals, are indispensable, partly for the construction of the tissue and its functions, partly for the metamorphoses of the organic combinations which are constantly going on, and that the definite quantity of these inorganic ingredients,

which daily again leaves the bodies of animals, ought to return to the soil, to be employed for the next generation of plants.

In these axioms, which now appear so simple, lay a whole treasury of foundation-stones for a scientific system of nourishment ; but Liebig has not been satisfied with giving prominence to the importance of inorganic ingredients in general ; he has still further pointed out the part which phosphoric acid, silica, silicic acid, lime, magnesia, and iron, on the one hand, and potash and soda on the other, appear to him to fulfil in the body of the animal, as well as in the plant. In carrying out this theory, however, it stands clearly and distinctly manifest, how much is required of the sanitary police, if they would not exert a disturbing influence in the universal household of nature, by measures, which, in other respects, are perhaps quite just and right ; and what, at the present day, in labours for the care of the public health has been represented as an almost new invention, was pointed out thirty years ago as a physiological necessity by Liebig.

But Liebig did not confine himself to demonstrating the value of inorganic ingredients for the development and the life of plants and animals. It was likewise he who first clearly showed that the nitrogenous and non-nitrogenous compounds, which, in vegetable food, are offered to the animal organism, must be introduced into it, in a certain definite proportion, as regards quantity, if, in other respects, this food is to be sufficient for the requirements of the organism. He fixed this proportion for healthy adults, at 1 : 4.7 (the non-nitrogenous substances reckoned as starch), he investigated this proportion for our working animals, and for those which supply us with meat and fat, and emphatically demonstrated what deviations from this proportion nature

has marked out as necessary for a growing organism, recognisable from the composition of the mother's milk. On the recognition of these proportions Liebig founded the composition of his well-known Children's Soup, and that, in this also, he did not neglect the inorganic ingredients, is well-known to every one, who, in the preparation of that soup, makes use of a prescribed and definite amount of potash.

In calculating and fixing these important proportions, for the nitrogenous and non-nitrogenous compounds, another consideration presented itself. We eat the nitrogenous compounds, those, namely, which form flesh and blood, in forms very various, it is true, but which, from a chemical point of view, are still much the same in value. The non-nitrogenous compounds, on the other hand, we eat in the form of starch, sugar, gum, on the one side, and of fat on the other. The first-named, so-called carbohydrates have, however, corresponding to their larger amount of oxygen, a much smaller value as food than the fat, and indeed to such a degree is this the case, that the nourishment value of one part of fat is equivalent to that of nearly 2.0 parts of starch or sugar. At the same time, however, it was already distinctly declared that, in prescribing any course of diet, the non-nitrogenous compounds must not be regarded as all of equal value; but, that, on the contrary, the fat, as being essential in the process of nourishment, on the one hand, and the carbohydrates on the other, must be estimated at their respective worth.

In these short remarks lie three of the most important laws of a scientific system of nourishment clearly explained before us. The first relates to the absolutely essential importance of the inorganic ingredients of food ; the second to the relative proportion of the nitrogenous and non-nitro-

genous compounds ; and the third to the distinctive nourishment value of the various non-nitrogenous compounds. Inestimable are the practical consequences, which are the immediate results of these laws. The most valuable guides are thus placed in the hands of practical physicians. We cannot be sufficiently thankful to the man who has laid down such fundamental principles.¹ But how has this gratitude hitherto been proved in action ? At this day it almost appears as if Liebig had preached to deaf ears, as if practical physicians were of opinion that they need not trouble themselves with these laws about food—as if practical medicine had nothing to do with them. But just as Liebig's rules for a rational system of farming, taught in the school of husbandry, have extended farther and farther, and found entrance and understanding even in the most remote farms, and will continue to do so more and more, so we may with confidence affirm, that, in the region of a practical care of health, the path will at length be opened up, and in the full estimate and acknowledgement of the deep importance of the rules he has laid down relating to food, Liebig will receive, even on the part of practical medicine, the gratitude which is due to him, and which finds its best expression in the practical application of his rules. Without that, practical medicine remains, as farming once did, a mere trade ; without that we cannot speak of taking care of the health in a physiological or scientific way.

When we glance over the progress which practical medicine has made in the last thirty years, we cannot fail to notice much that is great. Pathological anatomical research and Diagnostics, Surgical Technics, single depart-

¹ cf. Beneke, Physiol. Vorträge, 1856, Vol. I, page 289.

ments of Pharmacology and Therapeutics, have experienced a wonderfully quick and preponderating advance. But the practical application and promotion of that universal and special system of nourishment of which Liebig laid the foundation, has remained far behind. And so long as this part of a physician's duty receives no more careful and thorough treatment, so long as we do not know particularly to what irregularities the process of nourishment in sickness is subject, so long will the physiological medical art, and especially the understanding of constitutional forms of sickness, remain an impossibility.

Do I thus ascribe too much to Liebig, and too little to the practical medicine of our days? Only facts must decide.

We spoke first of the importance of the inorganic ingredients of the soil in the process of nourishment. "Without the alkaline bases of soda and potash," says Liebig, page 199 of his Chemistry and its application to Agriculture and Physiology, 7th edition, 1862, volume 1st, no vegetable acids, no starch, no sugar can be formed; without the phosphoric acid salts there can be no vegetable albumen;¹ phosphate of lime in particular is essential for the formation of the cellular tissue of plants.² It is only by the presence of the alkaline bases, that vegetable acids in the animal organism are fully burned down to carbonic acids.³ The phosphate of soda of the serum of the blood has the remarkable property of taking up the carbonic acid proceeding from the burning process, as well as that of giving it out with the

¹ Agricultur-Chemie, 1862, page 221.

² S. Chemische Briefe, 1851, page 638. Agricultur-Chemie, 1862, page 153.

³ S. Chemische Briefe, 1851, page 520.

utmost ease.¹ Acids and bases must always be so mingled in food that the alkalescence of the serum of the blood will be preserved.² In the cells of the blood and the juices of the flesh, salts of potash predominate.³ With the Extract of Meat we introduce substantially these salts of potash into the organisation; with a meat and especially with an egg diet, we however create a relative poverty in alkaline bases, and a super-abundance of phosphoric acid, for in the meat, phosphates of salts are chiefly contained as acid salts, and in eggs pure phosphoric acid preponderates so much, that, to thirty-eight parts of potash, we have one hundred parts of phosphoric acid.⁴

We come now to the idea, that phosphate of lime has its importance, not only as a material in the formation of the bones, but that it has also an essential share in the formation of the elements of tissue. We recognise that the inorganic bases, soda and potash, play a distinct part in the completion of the oxydation process; that certain salts possess an importance in absorbing gases into the blood, and again giving them out; that these and other salts are of immense importance for the process of diffusion. We obtain insight into the important difference in the distribution of potash and soda in tissues and the fluids of tissues, and we are imperatively called to careful consideration as to the proportion of acids and bases in the provisions which we present to the organism. To these few points alone I will here direct attention.

How highly Liebig estimated the importance of these

¹ S. Beneke: *Pathologie des Stoffwechsels*, 1874, page 336.

² S. Chem. Briefe, page 503, and further.

³ Chem. Briefe, 1851, page 546.

⁴ Vergl. Chem. Briefe, 1851, page 566 Anm.

inorganic ingredients appears from a letter with which he gratified me in the year 1852, in reply to my pamphlet, entitled "Unsere Aufgaben," which had been transmitted to him. It is there said, "An understanding of the part which common salt, or the alkalies, or the phosphates of salt, perform in the body, would please me better, or rather, appears to me more important than all the sublime theories of pathologists. To make progress, one must begin at the beginning." And in another letter written in the year 1848, he writes, "I am of opinion that many effects of diet can be traced to the inorganic ingredients contained in food. In a vegetable diet, such as bread, vegetables, &c., we cannot possibly exclude meat, chemically considered, in the form of gluten, vegetable albumen, and casein, but there it is accompanied by quite different materials from those in actual meat, and I believe I can show, by an analysis of the blood, that the changed blood mixture, which takes place by a vegetable diet, is to be ascribed to these other ingredients in the food. Phosphoric acid alkalies go out and pure alkalies come in their place."

Where however do we find a discriminating application of the facts mentioned to medical purposes? And if they could not be put to immediate practical use, where and for how long have people taken pains to ascertain the part which single inorganic ingredients perform not only during life generally, but also in curing diseases. Liebig's doctrine of the eminent significance of the amount of bone-earth in fertile fields, is the starting-point for the recommendation of phosphate of lime, as a medical remedy in diseases which are distinguished by great loss or poverty of lime. But though this recommendation is already twenty-four years

old,¹ only four years ago, there still existed the necessity of defending it against renewed attacks, which, however, were easily set aside, and even yet, it is only in individual circles that the full understanding of its unquestionable value has forced its way.² The importance of salts of potash for the process of nourishment, and in particular for the formation of the cells of the blood and of flesh, was in Liebig's opinion unquestionable.³ But only a few months ago, was the convincing experiment undertaken by Kemmerich which has proved that animals fed with squeezed out flesh residues, die, while they thrive and grow strong when potash is again skilfully added to the flesh residues. On the operation of these salts of potash, along with a small quantity of kreatine, sarcolactic acid, and sarkine, rests the effect of Liebig's Extract of Meat. Liebig has never left any doubt on the subject. And yet he himself was compelled, only two years before his death, to defend the Extract against the most irrational attacks from Russia and Sweden. M. Beljawsky in Moscow asserted that he had seen a dog starving of hunger, to which he daily gave 20 gramm. Extract of Meat (that is to say, Extract from 566 gramm. of Meat), in order to prove that the Extract of Meat contains no nourishment! By administering soda, we can quickly make the urine alkaline; if potash is used, the process, as it appears, is slower. With the former, in consequence of its quick passage into the secretions of the glands, and its neutralising effect on the juices of the stomach, we easily and quickly

¹ S. Beneke: *Der phosphorsaure Kalk in physiologischer und therapeutischer Beziehung*, 1850.

² S. m. Schrift: *Zur Würdigung des phosphorsauren Kalkes*. Marburg, 1870.

³ S. *Chemische Briefe*, page 562.

generate acid fermentation in the stomach ; with the latter, this disadvantage lies much farther off. Soda accelerates the formation of organic acids from the carbohydrates ; potash does not appear to do so in an equal measure. Yet notwithstanding, it is still customary to give soda, particularly as carbonic acid, without consideration and in large quantities, on the ground of a crude empiricism ; and people are scarcely beginning to pay attention to the different effects of potash and soda on the animal organisation. Of the peculiar effects of salts of potash on the nerves of the heart, people are beginning in modern times to speak with due emphasis. That, however, the destruction and loss of a number of blood corpuscles in fever, brings an abnormal amount of salts of potash into the blood of a fever patient, that the urine of a fever patient is very rich in salts of potash, is a fact that is scarcely discovered, and that is not yet considered in what is taught on the subject of fevers. While dwelling on the effect produced by salts of potash on the nerves of the heart, to which so much prominence is given in the present day, one forgets on the other hand their great importance in reference to the chemical changes in the system. That a deficiency in potash, and a relative superabundance of phosphoric acid, performs a part in many cases of chronic, so-called deforming gout, is becoming always more probable. Such a disproportion may possibly be induced either directly by a too abundant meat and especially egg diet, or indirectly, by excessive lactation, for instance, which we know to be one of the causes of that kind of gout.

Within the last twenty years, many valuable facts have been made known to us by means of excellent physiological experiments with reference to the physiological functions of

inorganic ingredients. As for instance the influence of common salt on the acceleration of the transformation of nitrogenous substances, the restraining influence of soda on the secretion of bile, the co-operation of mineral acids in withdrawing alkalies from the organism. But let us not be deceived by this circumstance, that in medical practice, little acquaintance with these inorganic ingredients is as yet perceptible, and medical questions, which, according to the present state of knowledge can be solved with the utmost certainty, are often still placed in doubt by the most superficial empiricism. This is almost nowhere more distinctly manifest than in mineral water cures, and particularly in the treatment of scrofulous, gouty, and tuberculous patients, in a word, of those afflicted with constitutional maladies. Every discerning man, however, can understand, that practical medicine, if it would lay claim to the epithet "scientific," must above all, seek to gain a clear understanding of the part which each separate and single ingredient of food, the substance by which the organism itself works, and by which the vital process is maintained, performs in that vital process.

With regard to inorganic ingredients, it may perhaps be allowed that there is some force in the objection, that, notwithstanding all past labours, their physiological functions are not yet sufficiently established, though this excuse can never be admitted for neglecting to solve the question itself. It is not so, however, with our above-mentioned second law, which relates to the proportion of the nitrogenous and non-nitrogenous ingredients in food. Here Liebig has laid down the most distinct directions with regard to the composition of food, and it was the task of practical medicine to make use of them, with a careful examination of the condi-

tions of sickness. But what appears really to be the case in this respect? The course of diet of the sick is in fact, even at the present day, in such a crude empiric condition, that one would be inclined to ask if, in the therapeutics of our advanced times, no attention is paid to the quality of food? And if we peruse the manuals of pathology and therapeutics of the present time, or if we listen to the dietetic prescriptions of several physicians for one and the same disease, we must come to the conviction that in this branch of medical achievement, there is a total want of fixed principles, and even of true science. "Let the patient be well fed; give him soup, eggs, milk, meat, in an easily digestible form," or in another case, "Give him a diet containing chiefly fresh vegetables." These are the very words of the manuals, and till this superficiality is done away with, it will fare ill enough with the most important task of the physician, especially in treating constitutional troubles. We know that a healthy adult human being eats nitrogenous and non-nitrogenous substances in the proportion of 1 : 5, and that this proportion in early childhood increases to 1 : 4. Unquestionably, there are maladies in which the relative quantity of nitrogenous ingredients must be increased, and others in which, *vice versa*, the non-nitrogenous compounds must exceed in the same ratio, not to speak here of the absolute quantities of each. The simplest consideration shows that a scientific diet must be so definite as to be able to say, "This patient must take the compounds mentioned in a proportion of 1 to x , that patient in a proportion of 1 to xx ," and so on, and at the same time it must of course be explained, how these proportions are to be attained. For this, however, it is certainly necessary that the alphabet of all systems of diet, namely, an intimate knowledge of the composition

of our most common victuals, with reference to both organic and inorganic compounds, should be familiar to every physician, and that at the present day such a demand requires to be made, proves how little, as yet, the great doctrines of Liebig, as regards the practical care of the health, have met with actual application.

And must I finally point out how much has been neglected the question as to the relative proportion of fat and carbohydrates which should be given in individual cases of sickness, nay, even in fixing the diet of the healthy? The majority of physicians look upon cod-liver oil as a preventive against scrofula and consumption: how far it possesses any importance as an easily absorbed kind of fat, is scarcely considered. In the non-professional Banting-cure which is used even by intelligent physicians with monotonous and uniform sameness, all fat is to be avoided, and only a minimum of carbohydrates to be taken, and physicians do not consider that a certain quantity of non-nitrogenous substance along with nitrogenous food is absolutely necessary to satisfy the demands of the organism, though cases may occur, in which a corpulent man may for a time take the fat which he needs from his own body; that, on the other hand corpulence is often found in individuals who have lived chiefly on meat. Whether the milk given to children is skimmed milk or unadulterated cow's milk, is seldom earnestly examined, and whether even Liebig's Children's Soup possesses a sufficient amount of fat for every case, is scarcely considered at all. And yet a rational system of diet cannot be imagined without the most careful attention to these questions, and that this attention is just as rare as an exact examination of the results of the food that is eaten, by ascertaining the weight of the body and by observations on its growth, is a

striking proof of the superficiality of the present practical system of nourishment.

We remarked by the way, that Liebig's doctrine with regard to the importance of inorganic substances, calls aloud for measures to be taken by the public sanitary commissioners, with respect to the removal of excrements from the towns. "Give back to the soil what you have taken from it in the form of vegetable food," is his simple, easily understood doctrine, which, at the present day may almost be styled a postulate of the human understanding, after the doctrine of the inexhaustibility of the fields has been set aside and acknowledged to be erroneous. The inquiry after the best methods of removing excrements from the neighbourhood of dwelling-houses, has never more deeply occupied the medical world than in the course of the last five or six years. But even in the treatment of this question by the assembly of Naturalists in Dresden, in the year 1868, one was met by the assertion that physicians have nothing to do with manure. That is the duty of the farmer. Certainly matters are now in a better state. It is acknowledged, that if physicians will interest themselves generally about the removal of excrements, they are bound by their duties, not only to farmers, but to their own flesh and blood, to their children and their clients, to recommend only such measures as will best secure the continuous fruitfulness of the fields, and by that means, will procure the best meat and milk at the most reasonable prices, and it is to be hoped that this view of the subject will never in future be lost sight of. It is simply throwing Liebig's most important doctrine to the winds to be guilty of negligence in this respect, and not to watch that animal and human excrements are removed from towns in such a way as that they may, with as little

diminution as possible, again benefit and fertilize the fields. It would be inexcusable to speak further in favour of such a measure as that of conducting these excrements into rivers, even leaving entirely out of sight the damage that would thus be done to the banks and to those who dwelt near the rivers. It is characteristic of the position still occupied by the inhabitants of many places even at the present day, that in Hamburg, the abundant contents of the beautiful system of sewerage may be seen committed to the Elbe, at a spot, opposite to which is situated an establishment for guano, that is to say, an establishment which brings from the islands of the Pacific Ocean, the very same substance, which, on the opposite bank, is poured, unused, into the bed of the river. And yet this establishment can scarcely import guano sufficient to satisfy the demands for it ! If we calculate the inhabitants of Hamburg at 240,000, it follows that the human excrements thence resulting produce yearly not less than 43,800 kilogramm phosphate of lime, and this enormous valuable mass is almost entirely lost so far as farming is concerned. In this calculation no account is taken of the masses of potash and phosphoric acid which are committed to the sewers with the water in which fish and vegetables have been boiled. These amount in London yearly to 600,000 pounds of potash,¹ and 207,770 pounds phosphoric acid. It is the general belief now that by the scheme of irrigating the soil all objections to the system of sewerage are set aside. But however praise-worthy it may be, to change unfruitful into fruitful land, it is also of material importance to preserve the fruitfulness of land actually fruitful. This task cannot, for various reasons, be accomplished

¹ cf. Liebig. *Reden und Abhandlungen*, page 129.

by irrigation, and thus we are brought more and more to the avowed conviction that sewerage is the very reverse of being the best system for removing excrements from towns, leaving entirely out of sight the fact that in many towns it meets with insurmountable difficulties. But, wherever, from whatever reasons, sewerage is preferred, farther measures will be necessary to preserve the contents of the sewers, and, in the most complete way possible, to make them beneficial for farming.

It is only facts which I have here brought before you—only facts on which I have sought to rest the proof that Liebig's comprehensive doctrines on the subject of a practical care of health, are as yet very far from being applied and practised with all that care and earnestness which their deep truth and extraordinary importance demand. This is the natural consequence of the truth, that, in the course of study prescribed for physicians in the present day, a universally physiological education and culture is not required, and consequently is not pursued with an energy corresponding to its high importance for the physician. But Liebig's merit is not thereby diminished. The fundamental principles of a right system of nourishment still stand immovably fast, and if ever, at some future time, the firm structure of a rational system of diet arises, from which all practical physicians derive counsel and instruction, it will rest on no other foundation than that which Liebig has laid.

These are the memorable words of Liebig in his expressed opinion "On the study of the natural sciences, and on the state of chemistry in Prussia," in the year 1840.¹ "So long

¹S. Reden und Abhandlungen von J. von Liebig, 1874, page 27.

as the scientific physician neglects to make natural science and especially chemistry and experimental physics the subject of the most minute and thorough study, and indeed as preparatory sciences for his chief department, no light will be thrown on medicine in its most important problems, namely, in removing and setting aside abnormal conditions in the organism." These words will remain an eternal truth. And again with perfect justice Liebig a few years ago asserted that it must be imperatively demanded of those to whom the care of the nourishment of whole classes of society is intrusted, that they should know at least as much of the nature of different kinds of food, as the farmer knows of the fodder with which he preserves in a good and healthy condition his oxen, from which he looks for work, his cows from which he hopes for milk, and his sheep from which he expects wool.¹

But Liebig belonged to those great creative spirits who bring blessing to the world, not only by bold and clearly sketched ideas and combinations deducible from unquestionable facts. He must also be numbered among those privileged ones who at the same time discovered and invented methods by which the labourer is enabled to obtain a speedy and certain answer to questions he puts to Nature—methods, by which he himself soon succeeded in placing the actual proof side by side with his own views. And as in this department of his labour, he did invaluable service to analytical chemistry by the exposition of a new method of organic elementary analysis, so he has benefited physiology and practical medicine in an equal measure, in particular by the invention of the simplest methods of analysing the urine.

¹ *Reden und Abhandlungen*, page 132.

With regard to the most important phenomena of tissue-transformation in healthy as well as in sick people, very little definite was known till about the end of the year 1840.

Determinative experiments with regard to the urea in the urine, as the most important final product of the transformations of the nitrogenous constituents of the body, were a waste of time, uncertain, and practicable only to a few ; definite conclusions as to the quantity of the inorganic ingredients of the secretions were very rare. In order to obtain definite information as to the carbonic acid excretions from the lungs and through the skin, there was scarcely any method known. Then Liebig introduced his incomparable and invaluable volumetric analysis, for ascertaining the most important ingredients of the urine, and he has thereby presented a gift to physiology and pathology for which sufficient gratitude can never be paid him. To this method we are chiefly indebted for the knowledge on which, at the present day, the doctrine of tissue-transformation in healthy and sick people rests. To it we owe our information as to the effect of bodily exercise, of water drinking, of common salt, of the influence of fever, and a hundred other things on the nitrogenous and inorganic constituents of the body. What a wealth of experience has sprung from this one fountain, opened up by Liebig ! And when soon after a further apparatus for determining the products of tissue-transformation in discharges from the lungs, and exudations through the skin, was constructed in the form of the great so-called respiration apparatus, I believe I am not mistaken when I say that the originator of this also is to be sought chiefly in Liebig, and certain it is that, without Liebig's potash bulbs, this other important apparatus would not have come into existence. Under Liebig's direction and by his advice such

an apparatus was already at the beginning of the year 1850, constructed in Giessen, by Jul. Vogel, and what was not satisfactorily effected there, was soon afterwards again fully completed with Liebig's assistance in Munich. Now a hundred robust powers are labouring to work out the doctrine of tissue-transformation in conditions of health and of sickness. We stand midway in an age in which this important department is almost daily enriched with new experiences. But it was Liebig who created the tools for this purpose. And these tools have served only to confirm more and more the full accuracy of the universal physiological ideas which the master's creative genius announced. The perfection of our optical instruments has brought about the great progress in which the anatomical department of medical research rejoices. What the microscope is for anatomists, Liebig's chemical methods of labour have become for physiologists and pathologists, and even one less gifted may now, with their help, combined with his own conscientious efforts, obtain for himself, independently of other assistance, insight into the action of vital processes, and may thus solve for himself this or that physiological or pathological question.

As a particular branch of medical effort, public sanitary arrangements have been receiving increasing attention. Those who have written on the subject have at times done so in a tone which seemed to assume that such arrangements were an entirely new invention. The eager effort to apply practically, long-established scientific experience is certainly new and praise-worthy. But who will attempt to deny that the most essential principles even of this department were already laid down by Liebig long years ago, and that in carrying out the duties of the Board of Health, we come at

almost every step on questions, which, but for Liebig's previous labours, would never have been at all intelligible?

How essentially necessary Liebig's labours in universal physiology and agricultural chemistry have been in forming an accurate judgment of the value of human and animal excrements, and how imperative it is that his doctrine on the subject should influence the measures taken for the removal of the last from the neighbourhood of human dwellings, has already been prominently brought forward.

The quality of the water we drink, and the importance of its inorganic ingredients in nourishing human beings, was first accurately comprehended by Liebig, next to Boussingault. The change of air in close and crowded rooms, and its hurtful influence on the health, was, with special reference to schools, theatres, ships, &c., emphatically brought forward by Liebig.¹ The great importance and the physiological value of those wide-spread articles of diet, tea, coffee, and brandy for the nourishment of the people, no one ever before so clearly represented as Liebig,² and even if his teaching as to tissue-transformation might perhaps impel us to the opinion that he has comprehended and estimated the vital process only from a chemical point of view, still here as well as in his farther treatises on the importance of Kreatine in the Extract of Meat, and of wine as the old man's milk, he makes it clear, how accurately he computed the influences exercised by the nervous system in the course of the vital process. Lastly, on the nature of contagion, even in the year 1840, Liebig expressed opinions which in part have received full confirmation by the researches of

¹S. Reden und Abhandlungen, page 132.

²S. Chem. Briefe 1851, page 603 and further. Reden und Abhandlungen, page 134.

modern times.¹ He saw in the different kinds of contagion, ferments, which call forth various effects according to the nature of the sub-strata on which they fall; what appeared to him only probable was confirmed as a fact by Schönbein in the case of various contagions, as for instance, those of syphilis and small-pox, and from this starting point, even in the present day, the measures of the public Board of Health, as in cholera, dysentery, typhoid fever must set forth.

The fulness of thought and positive achievement which is implied in all these details, and by which Liebig did good service to practical medicine, is quite extraordinary, so extraordinary, that even among those whose peculiar department is pathology, only isolated names are to be found of equal importance to practical medicine with that of Liebig. The reason for this lies deeper. An individual with one single department may accidentally, by a fortunate discovery, a happy idea, be more successful in finding out single facts than another. One single fact may also by its extent, fully outweigh the value of dozens of other facts. What however makes Liebig so exceptionally great, as being so rarely to be found, is the wide horizon of his mental eye, manifested in the comprehensive nature of his labours and doctrines, in taking into account the connection existing between all the phenomena of life. On this is founded the revolution which he produced in the entire comprehension of the vital processes, the sharp indication of the duties he assigned to physiology and practical medicine, the lucid exposition of a scientific method of labour, such as he has exemplified or at least has striven to mark out in the department of practical

¹ S. *Agricultur Chemie* 5, Aufl. 1843, page 409, &c.

medicine. If we would reach a definite aim, we must know the paths which lead to it. The construction of a genuinely scientific system of medicine, was the aim which in Liebig's opinion constituted the task of physicians, and the uncertainty of all former systems was so well known to him, that he designated the condition of medicine before the year 1840, as a "pitiable" one.² The roads leading to this goal, were, however, not dubious to him. He wished to see the same questions put to the animal organism as had been put to the vegetable, after the acquisition of a familiar acquaintance with the "language of physiology," that is to say, the substances which compose that language. And as in agricultural physiology so also in animal physiology, he wished to gain a near insight into the conditions of healthy and sickly life by means of observation and experiment. His writings breathe throughout the irrefragable certainty that the life of animal organism cannot be understood in all its phenomena unless it is taken up in its natural connection with the whole of surrounding nature, and thus Liebig has marked out for the development of scientific medicine those paths by the increasingly eager pursuit of which the noblest results are already partly won, but, for the most part, are still being won. Liebig has taught us to put correct questions to the healthy and the sick organism, and the answers will not be wanting, if we make use of the same methods of labour, and exercise the same indefatigable perseverance by which he himself has attained such great results in the region of vegetable physiology. This is to be a true pioneer, and he who has succeeded in this first step, has done more than all those who afterwards remove out of the way single

² Reden und Abhandlungen, page 22.

heaps of rubbish, smooth the path, and surround it with firm fencing ; he has opened up the prospect into the distance, he has shown where the land of the future lies. "What hinders the progress of medicine," wrote Liebig to me in the year 1852, "is unquestionably the circumstance, that the majority do not know where the proper attack is to be made in order to grasp permanent facts. Through the want of right points of attack the strength is dissipated." Now, the points of attack are given, and generations of physicians will still find productive work, if they start from them according to a clearly premeditated plan.

Liebig was in the prime of life when pathological anatomy made the most important progress, and threw a clear light on all pathology together. He did not misapprehend the far-reaching importance and necessity of this branch of knowledge. He praised the astonishing labours of anatomists. But he found no satisfaction in anatomy. He wished to study life in living beings. Of higher value than the power to pronounce on the ultimate results of sickness, appeared to him the discovery of the causes which bring about these results. It was only by the knowledge of these causes that he saw any possibility of making medicine the true helper of suffering humanity. Along with the recognition of the laws of nature, and such an understanding of natural phenomena as accompanies such a recognition, he had always practical aims in view. To promote the happiness, the health and prosperity of his fellow men, stood before his mind as the goal of scientific labour. It was for him a postulate of the understanding that, just as certainly as definite causes call forth an anomalous state of the vital processes, so also definite and clearly indicated ways and means exist, either to prevent that anomalous state, or in the

event of its not having reached an irreparable height, to bring it back to the normal condition. It might well be depressing for Liebig to see how slowly the labour of practical medicine proceeded on the path marked out by him. Yet still he has lived to witness the birth of a system of experimental pathology and therapeutics, and to see a large number of the German physicians accept the doctrine that practical medicine must look upon the prevention of disease as its highest task. But even here Liebig did not confine his labours to an estimate of the purely material processes in man, to an examination of the functions of separate ingredients of food, and separate constituents of the body. With his comprehensive eye, he also took note of all that from other directions determines the bodily state of men, the influences exerted by individual and social life on the health of individuals and of society. To find out these influences he regards as the office of statistics, which are inseparably connected with the farther offices of biology. "It is clear," he says in the conclusion of his twenty-eighth chemical letter, "that a knowledge of the true means of bringing human society nearer to a better state, and of laying a permanent foundation for the happiness of nations, can only be attained by enquiring into the influence of all modern arrangements, usages, customs, and institutions, on the morality of men, by means of the census. This is the true work of the naturalist."

Finally, may I be permitted to notice one other point? This is the view which Liebig has in various places expressed as to the influence of the study of chemistry, not only on the full education of the physician, but on the education of men in general, and hitherto physicians have certainly maintained their right to be classed

among educated men. At the very beginning of his chemical letters, page 1st, Liebig says, "Would that I could only succeed in confirming the conviction that chemistry, as an independent science, presents one of the most powerful means of higher mental culture, that the study of it is useful, not only in so far as it promotes the material interests of men, but because it affords insight into the wonders of creation which immediately surround us, and with which existence, continuance, and development are most closely connected." And in another place¹ he says, "Without the knowledge of natural laws and natural phenomena, the human mind will make shipwreck in its attempt to form to itself an idea of the greatness and unfathomable wisdom of the Creator, for all the images which the richest fancy and the highest mental culture can create, appear, when compared with the reality, nothing but gay, empty, many-coloured soap-bubbles." "How strange that the expression 'education' in a truly enlightened nation should extend only to classical languages, history, and literature! The questions as to the causes of the natural phenomena, the changes that take place in all that daily surrounds us, are so suited to the active human mind, that the sciences which give a satisfactory answer to these questions, more than all others, exert an influence on the cultivation of the mind."²

When we survey these achievements of Liebig's, and add to them those which he has accomplished in his own peculiar domain, that of analytical organic chemistry, and as a natural consequence also in the domain of rational farming, we can form no other image of him than that of a mighty ruler, who, in the evening of his life, reigns over wide kingdoms con-

¹ Chem. Briefe, 1851, page 26.

² S. Reden u. Abhandlungen, 1874, page 12.

quered by his own mental power, and who sees, as his reward, the fruits of his toil springing up in rich and still richer abundance. Never, certainly, did any intellectual hero win a more costly victory, or conquer a richer field. And though he won that victory not without battles against folly and envy,¹ never, perhaps, was a conqueror at the end of his earthly course, surrounded by a greater number of friends and worshippers than Liebig.

Outward marks of honour and distinction were not wanting to him. But as the time approached when greater rest was needed, when he himself no longer laboured incessantly to bring forward convincing facts, then we do not find him, carried away by just pride, resting on his laurels, but rather testing, by quiet mental labour, how far the history of humanity confirmed the accuracy of his doctrines, and guaranteed the continuance of his kingdom. The completeness of his mental horizon, manifested in the new edition of his "Agricultural Chemistry," the depth of historical and philosophical study which meets us in the first volume, are the genuine marks of Liebig's uninterrupted progressive intellectual labour, and his ever-widening circle of thought. He was not satisfied with the facts which he brought to light, with the clear and certain practical inferences which he drew from them, and the accuracy of which was confirmed to him by a thousand witnesses. He belonged to the order of minds that only feel true inward satisfaction when they attain to the conviction that their own views and opinions are in harmony with all the truth and experience which past times conceal in themselves, with all, which, in the present time, stands in relation to the narrower circle in which their

¹ Vgl. Kolbe in the Journal "Unsere Zeit," Jahrg. 1874, No. 11.

own labour is exerted. And when we peruse the preface to these immortal works, we meet with a noble mind so filled with gratitude to his former teachers (Thenard, Gay-Lussac, Dumas), with such winning testimonies of humility in speaking of the errors into which he himself for a time had fallen, that the perfect image of the great master cannot fail to win not only the admiration of the learned, but the full love of all men. In our own time, in many ways so irreligious and ungrateful, it is a blessing to find a master of the first rank full of thankful feelings towards his teachers, and this feeling continued with Liebig even to his death.

Let us now make a summary of these hasty remarks.

By his great sketch of the picture of the circulation of matter, and by the discovery of the importance of the separate ingredients of food, Liebig has laid a permanently sure foundation for a system of nourishment to men, and pointed out part of the way in which constitutional troubles may develop themselves, and by which, in another direction, they may be rectified. By completing the method of examining animal secretions and excretions, he has most materially contributed to the progress of pathology and therapeutics. By numerous examinations and clear inferences from his principal doctrines he has pointed out the way in various directions, to public, as well as private sanitary measures. By his imperishable works, he has at the same time proved on satisfactory evidence to every intelligent physician, that, without a complete physiological foundation, a general understanding of what happens in nature, it is impossible to acquire a scientific system of medicine. By his penetrating and comprehensive studies in history, he has given an admonition to younger generations not to forget the experiences of the past in the solitary attainments of the present,

and always to be mindful of the coherence of all natural phenomena, as well as of the independent judgment, required by every isolated fact, from the intelligent naturalist. In conclusion, we see the great master, in all the magnitude of his own achievements, never forgetful of the gratitude which he owes to his predecessors and teachers, and in humility he calls himself the “impotent worm,” when he calls to mind the greatness of Nature and her Creator.

Happy he who can look back on such a life, full of toil and labour, but full also of the richest success ! But happy also those who can reckon such a spirit as their own, and who, in recalling his image, not only feel constantly a new impulse to strive to follow his lofty example, but who, thankful for all the treasures of knowledge which the departed has left behind him, lay down the laurel on his honoured resting-place !





